Ph.D. Synopsis in the Faculty of Science and Technology

Subject: Botany

Research title: Studies on Silicate Solubilizing Microorganisms on Yield of Cotton (*Gossypium herbaceum* L.) with Reference To Kandhar Taluka of Nanded District, Maharashtra.

1. Research student :Miss. **Bhagyashree Bhagwan Chavan**
   Qualification :M.Sc. (Botany)
   Address :
   Tal.- Kandhar ,Dist. : Nanded

   State - Maharashtra, India

   E-mail: Santoshrathod00143@gmail.com

   Mobile: 7020783406,7499169934.

2. Research Guide : Dr. R.G. Chillawar

Qualification : M.Sc. B.Ed. Ph.D.

Address : Department of Botany Yeshwant Mahavidyalaya Nanded -431602 (M.S.) India

E-mail:rchillawar2010@gmail.com

Mobile: 9527537359, 9421841118

Ph.D. SYNOPSIS

In The Faculty of Science and Technology

Studies on Silicate Solubilizing Microorganisms on Yield of Cotton (*Gossypium herbaceum* L.) with Reference To Kandhar Taluka of Nanded District, Maharashtra.

SUBMITTED TO THE

Swami Ramanand Teerth Marathwada University, Nanded

FOR THE DEGREEOF

DOCTOR OF PHILOSOPHY IN BOTANY

UNDER THE FACULTY OF SCIENCE AND TECHNOLOGY

BY

MISS. Bhagyashree Bhagwan Chavan

M.Sc. (Botany)

UNDER THE GUIDENCEOF

Dr. R. G. CHILLAWAR

M.Sc. Ph.D.

At

Post Graduate Research Centre

Department of Botany

Yeshwant Mahavidyalaya Nanded

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Introduction:

For their growth plants absorb various types of macro and micro elements as nutrients for their growth. Silicon (Si) is the second most abundant element (27%) which occurs in the unavailable forms of silicates (SiO_3) of aluminum, magnesium, calcium, sodium, potassium or iron (Pilon-Smits et.al.,2009, Malhotra et. al., 2016). The useful effect of silicon (Si) for healthy crop production has been reported. (Farooq, Dietz 2015) However Si considered a non-essential element. The recent study has proved its beneficial role in quality production especially in the case of hyper-Si accumulator plants such as rice.

A thousand of research articles are published over the last couple of decades evidently is said that Si supplementation is useful for the growth and development of plants as well as animals. Therefore, increasing Si uptake in crop plants to achieve a better yield, particularly under stress conditions seems a more sustainable approach. Silicon used as a fertilizer provides benefits against plant diseases, environmental stresses and improves soil fertility by increasing water holding capacity, nutrient balance and maintain the physio-chemical properties of soil. (Meena et. al., 2014 a).

Bio fertilizers are one of the important components of integrated nutrient management, as they are cost effective and renewable source of plant nutrients, ecologically safety instead of chemical fertilizers (Raja, 2013). Different kinds of promoting plant growth microorganisms can be used for the production of biofertilizers. Silicate solubilizing bacteria can play an efficient role not only in solubilizing insoluble forms of silicate but also potassium and phosphates, hence increasing soil fertility and enhancing plant productivity (Han and Lee, 2005).

Cotton (*Gossypium herbaceum* L.) is the world's most important crop native of tropical and subtropical parts, belongs to family – Malvaceae cultivated for its fiber. The fiber is almost pure cellulose. India is World's largest producer of cotton. Now a day's climate change is a serious problem to field crop production. The yield of this crop plant is affected by different climatic conditions, soil parameters and chemical fertilizers. (Tanzi and Charles 2020).

The extensive use of chemical fertilizers poses serious problems such as environmental pollution, pest resistance development and food safety (Lin Ye et. al., 2020) Chemical fertilizer increase the yield of crop but only the use of chemical fertilizer is toxic which decreases soil fertility. Continuous application of chemical fertilizers will make the soil more acidic that will

kill microorganism in the soil, therefore decreasing the amount of microorganism lead to decreasing crop productivity. Plants need many macronutrients and micronutrients for their growth and development. Silicon is a component of mineral particles of varying size. Sand is largely composed of silicon dioxide; this material provides very little soluble or plant available silicon. Silicon is one of the important micronutrients require for plant growth and productivity. The aim of this study is to check the effect of silicate solubilizing microorganism, as a biofertilizer and study its effects on crop yield and soil properties.

Repeated cropping reduces the level of plant available silicon, thus enforcing the application of silicon fertilizers in forms of finesilica, sodium /calcium / potassium silicate, along with other chemical fertilizers (Datnoff and Rodrigues, 2005). Crops may benefit from disease suppression, reduced injury from insect pests, stronger stems, and tolerance to stress, or direct stimulation of yield from supplemental silicon application. Some silicon fertilizers supply other nutrients, neutralize soil acidity and serve as liming material. The greater the lime requirement of the soil, the higher the application rate possible for calcium silicate.

Most of the nutrients are already present in soil but they are in insoluble forms so plants can't take these nutrients directly, they need some medium so the microorganisms present in the soil help to convert the insoluble form of nutrients into soluble form. This allows the plants to grow properly and increase yield.

Over the last two decades, several studies have proved the beneficial role of Si in the growth and development of vascular plants. The accumulation of Si is generally higher in ferns and monocots compared to other plant species (Hodson et. al., 2005; Farooq and Dietz, 2015). Exploration of Silicate Solubilizing Bacteria (SSB) will provide more sustainable, environment friendly and economical option to improve Si availability for crop plants and ultimately improve agriculture production.

Specific benefits observed due to silicon nutrient are extensive

1. Direct stimulation of growth and yield.
2. Counteracts negative effects of excess N nutrition.
3. Suppression of stem borers, leaf spider mites, and various hoppers.
4. To decrease various environmental stresses.

Review of Literature:

Meena et. al., 2014a; Wang et.al., 2015; Kang et. al., 2017; Kumawat et. al., 2017; Chandrakala et. al., 2019; Lee et.al., 2019. Due to common mechanism of solubilization(organic acid production) and qualification method (molybdenum blue method) for both phosphate (P) (Fiske and Subbarow, 1925) and silicon (Si)(Elliott and Synder, 1991) there is unavailability of a concrete silicon- solubilizing media.

Joseph Heckman (2017) reported thatin the nature Silicon is always bonded with oxygen and other elements in the crystalline fabric of mineral soil. If we analyze total elemental of typical mineral soil is about 27% Silicon and 47% Oxygen. The crystalline fabric of mineral soil with weathering and time, some of this vast supply of silicon is released in soluble forms available for uptake by plants. Silicon as a fertilizer is beneficial to many crops when added to soil. Some types of algae and horsetail (Equisetum) cannot survive without a supply of silicon from the environment. Many of the plant's species, especially grasses, can take up silicon in amounts comparable to macronutrients. This high concentration of silicon in the plants contributes to plant mechanical strength. Also, the structural role of silicon is to protect plants from insect attack, disease, and environmental stress by improving the plant's defense response. The commonly used silicon fertilizer material also serves as liming agents and their application results in neutralization of soil acidity. Soil pH measurement and tests for lime requirement are useful guides for determination of how much of certain types of silicon fertilizer products may be applied to a given field soil.

Chandrakala et.al., (2019) said that the studies have reported weathering of silicates by bacteria for its dissolution to make it available to plants. The liquid screening media containing different silicon sources developed by different groups viz. feldspar, muscovite, biotite, and magnesium tri-silicate with soluble phosphate sources (di-potassium hydrogen phosphate; K_2HPO_4 and di-sodium hydrogen phosphate; Na_2HPO_4) and agar-based media containing glucose and magnesium tri-silicate as only source of nutrition.

Sheng et. al., (2008), Kang et. al., 2017; Vasanthi et. al., (2018).Many of bacterial strains of genus *Bacilluscaldolyticus, Bacillus mucilaginosus*var.*siliceous, Proteusmirabilis, Pseudomonas*, Rhizobia, Burkholderia, and Enterobacter are known to release silicon from silicate and promote plant growth.

Narendra Kumawat et.al., (2019) said that all over the world, loss of the health of soil is main constraint causing reduced soil productivity and fertility, and it also affect the crop yield intensive use of land by farmers, without undertaking appropriate nutrient management practices, results in the removal of more nutrients from soil, which reduced the productivity of crops for the growth and development, plants required various nutrients in different ratios. Plants obtain all these nutrients from soil, water and air. Some nutrients are required in large amounts where as others areonly in small quantities for the plant vegetative and reproductive growth. As per recent study, reduced yield is mainly associated with reduction in the appropriate supply of nutrients by the soil

AIMS AND OBJECTIVES:

1. To procure silicate solubilizing microorganisms.
2. In-vitro multiplication of Silicate Solubilizing Microorganisms and evaluation of silicate solubilizing activity.
3. To study the formulation of the strain solid and liquid.
4. To study survival of the Silicate Solubilizing Microorganisms in solid and liquid state formulation
5. To study the effect of effective formulation on yield and post harvested soil nutritional status.

RESERCH METHODOLOGY:

1. **Procurement of Culture:** The silicate solubilizing microorganisms will procured from i) Agarkar Research Institute. ii) National Chemical Laboratory and safely transferred to microbiology laboratory.
2. **Multiplication of procuredculture**: The procured silicate solubilizing microorganisms are multiply on suitable nutrient medium.
3. **FormulationofsilicatesolubilizingMicroorganism:** Solid state formulation will be prepared by using suitable filler and liquid state formulation by using certain cell protectant adjuvants.
4. **Study of survival of Silicate Solubilizing Microorganisms :**Study of survival in liquid and solid state formulation i.e. TVC (Total Viable Count) quality parameter and efficancy will be studied.

5. **Field trial and Post-harvest soil analysis**:The soil analysis will done by using standard method (Tandon 2005).

EXPECTED OUTCOMES (possible outcome of the research)

1. The research will lead to enhance the uptake of silicon from soil.
2. The research willlead to know the effective strain of silicate solubilization.
3. The research will lead to know the low cost, eco-friendly, effective liquid and solid state formulation of silicate solubilizing organism.
4. The research will lead to know the effect of Silicate Solubilizing Microorganisms on soil health and yield of study crop.
5. The research will lead to know the role of Silicate Solubilizing Microorganisms in cotton crop.

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(Miss B. B. Chavan) (Dr. R.G. Chillawar)

Research Student Research Guide